

Wideband Array for C, X, and Ku-Band Applications with 5.3:1 Bandwidth

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INTRODUCTION

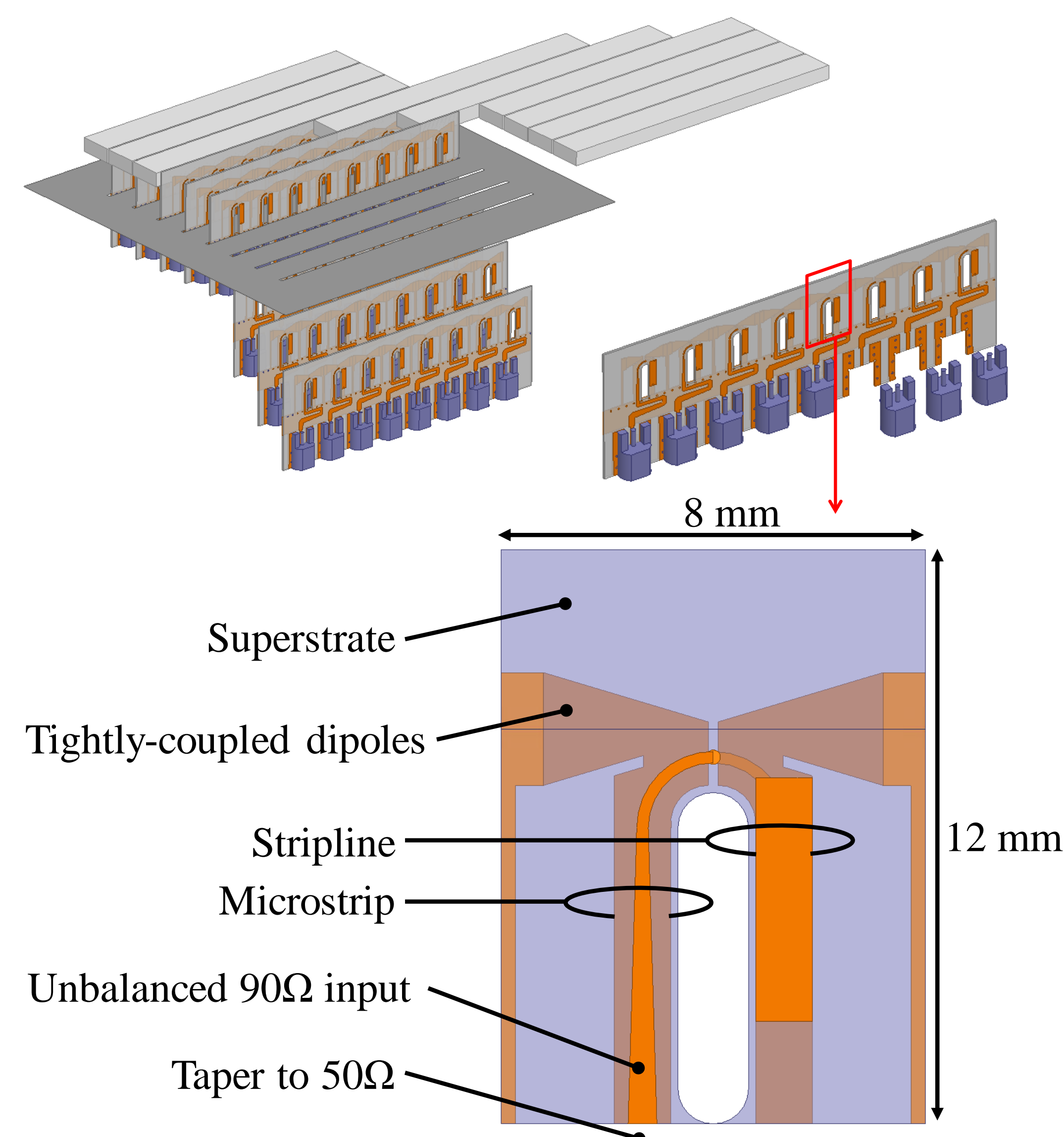
Satellite communication has largely been accomplished using reflector antennas. However, such antennas are inherently bulky, and rely on mechanical steering. For this reason, ultra-wideband (UWB) and beam forming arrays have received strong interest. These lower weight, size, and cost arrays can combine many satellite applications spread throughout the C–Ka bands (4–40 GHz).

To this end, we seek to develop an UWB Tightly-Coupled Dipole Array (TCDA) with the following attributes:

- UWB band operation (3.5–18.5 GHz) with low loss
- 45° or more scanning in all planes
- Low-cost Printed Circuit Board (PCB) fabrication
- Scalable to Ka-band and above

DESIGN

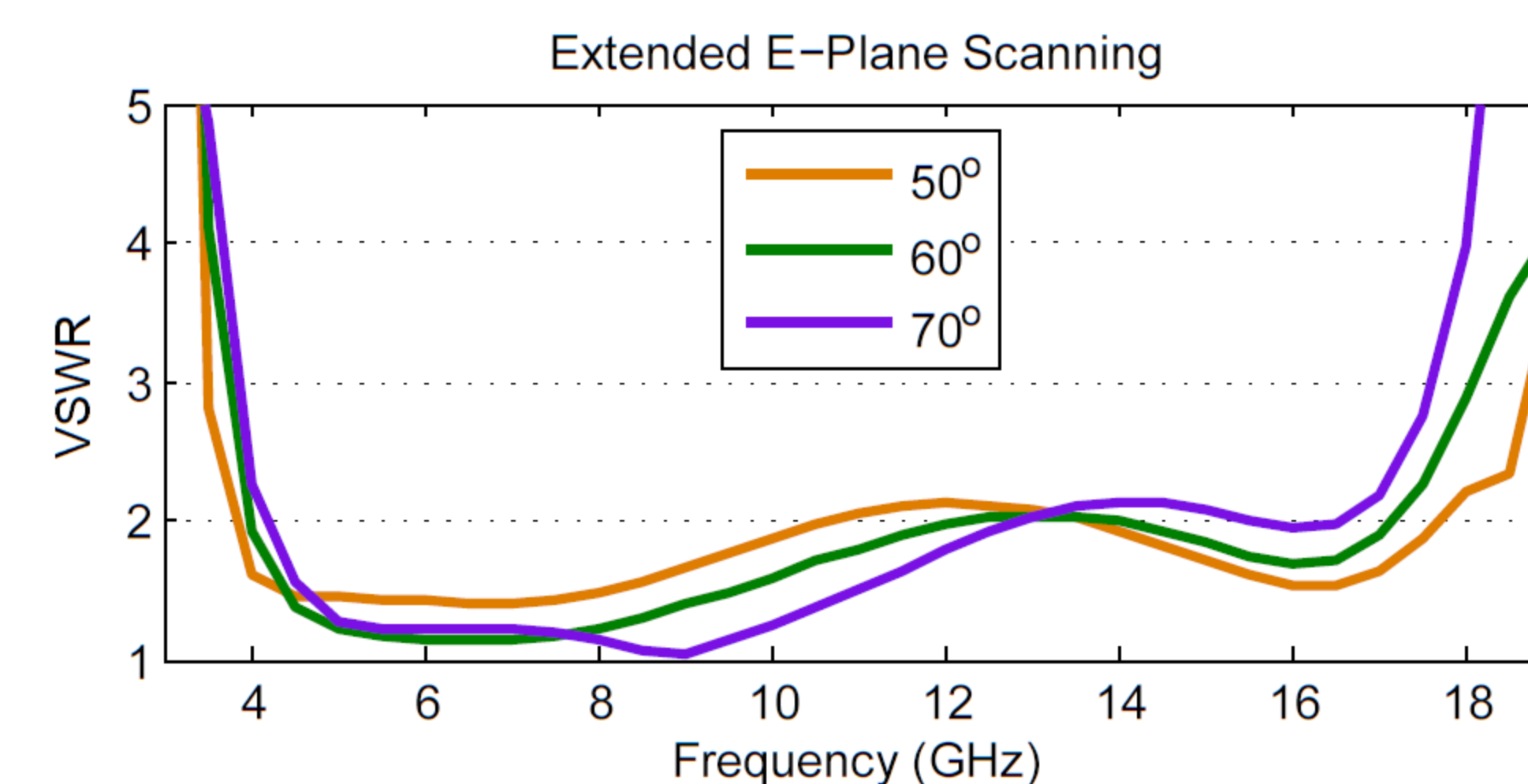
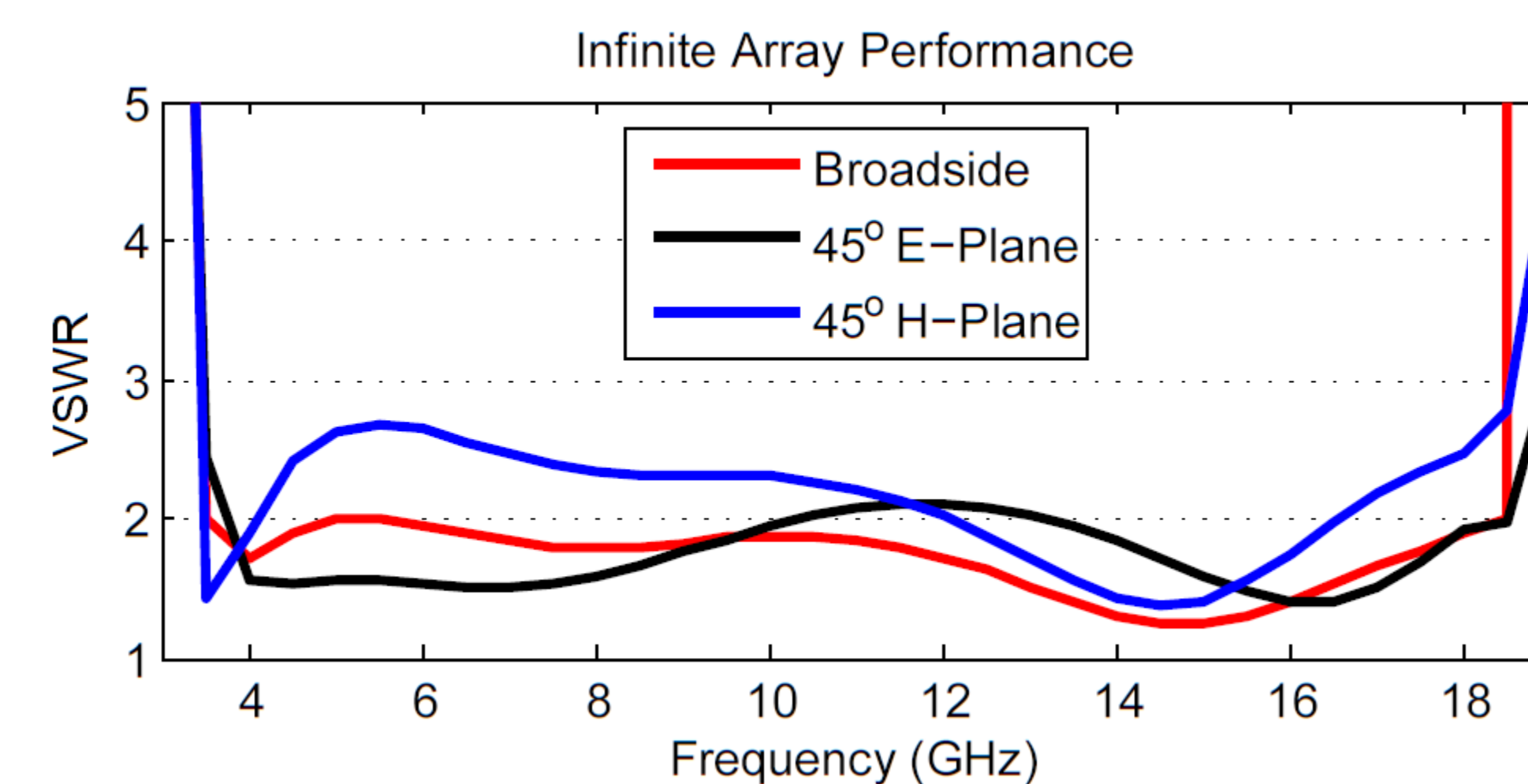
Compared to previous designs (<5 GHz), the primary challenge at 18 GHz is realizing a wide range of impedances in the balun, while maintaining fabrication tolerances, and avoiding spurious resonances. This is accomplished here with a hybrid microstrip-stripline balun and vertical shorting posts.



SIMULATION

Infinite array simulations are carried out in HFSS, and VSWR curves are plotted in the figures below.

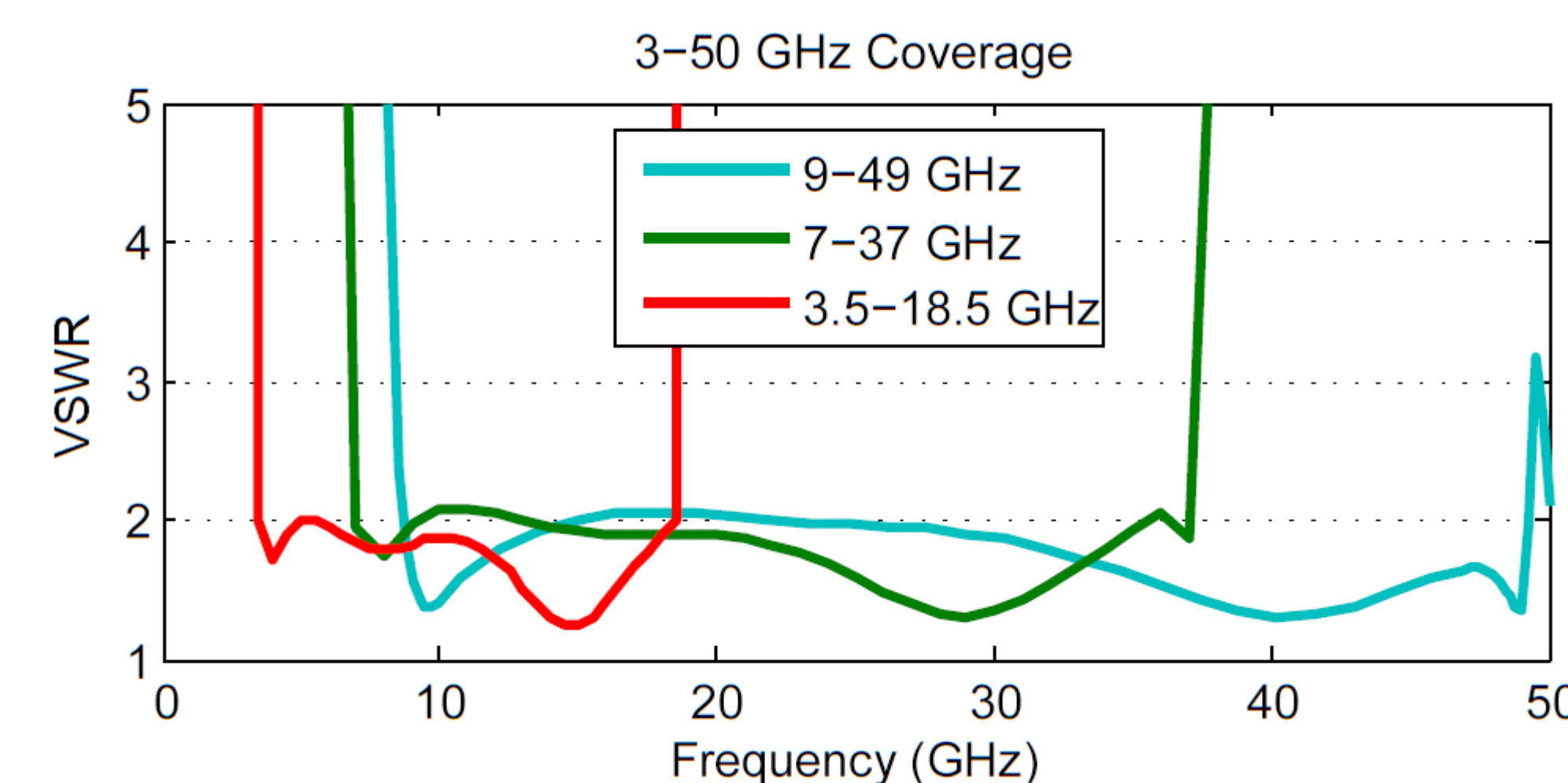
- 5.3:1 bandwidth from 3.5 GHz–18.5 GHz, with VSWR < 2 at broadside
- VSWR < 2.1 at 45° scan in the E-plane and VSWR < 2.6 at 45° scan in the H-plane
- E-Plane scanning to 70° with VSWR < 2.2, while maintaining 88% of the broadside bandwidth



SCALABILITY

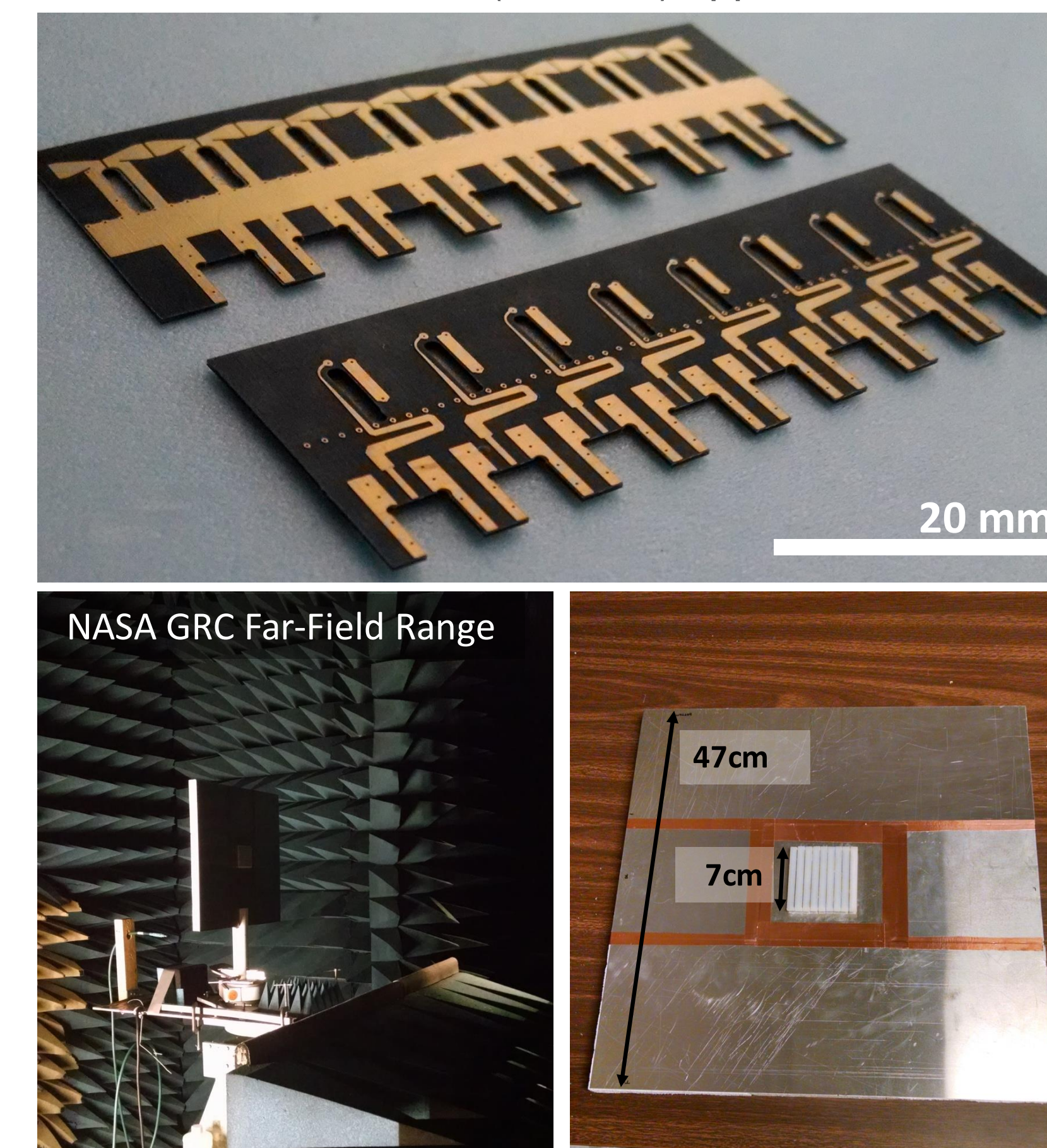
As the array is designed with generous tolerances, it can be scaled to Ka-band and millimeter wave frequencies:

- 3.5–18.5 GHz → 200μm minimum feature size
- 7–37 GHz → 100μm features
- 9–49 GHz → 75μm features (State of Practice)

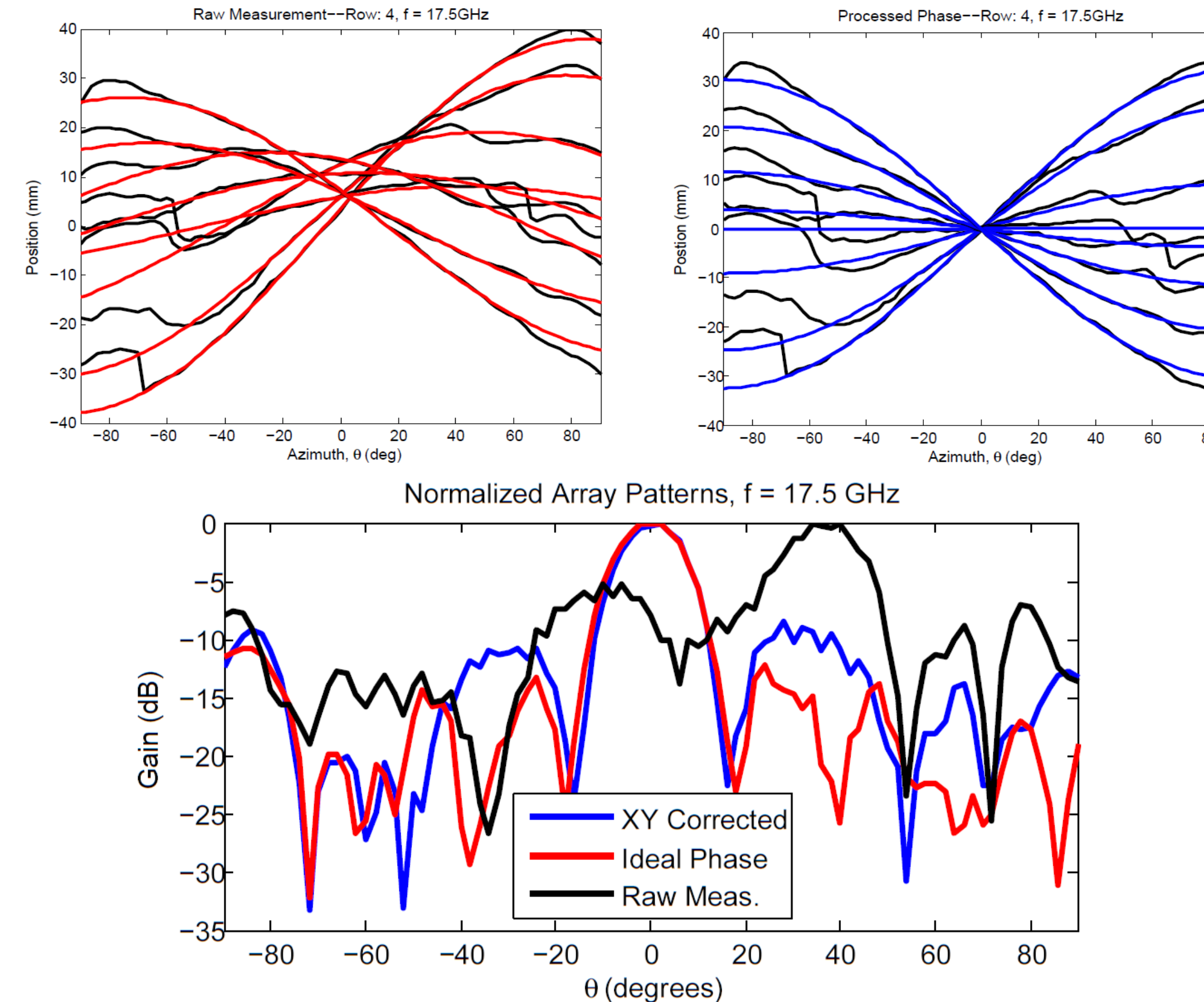


PROTOTYPE MEASUREMENT

An 8x8 prototype array was fabricated as 8 rows of 8 elements. The array is printed on 3-layer Rogers Duroid 5880. Measurements were conducted at the NASA Glenn Research Center Far-Field Range, using the Unit Element Active Excitation Pattern (UEAEP) approach.

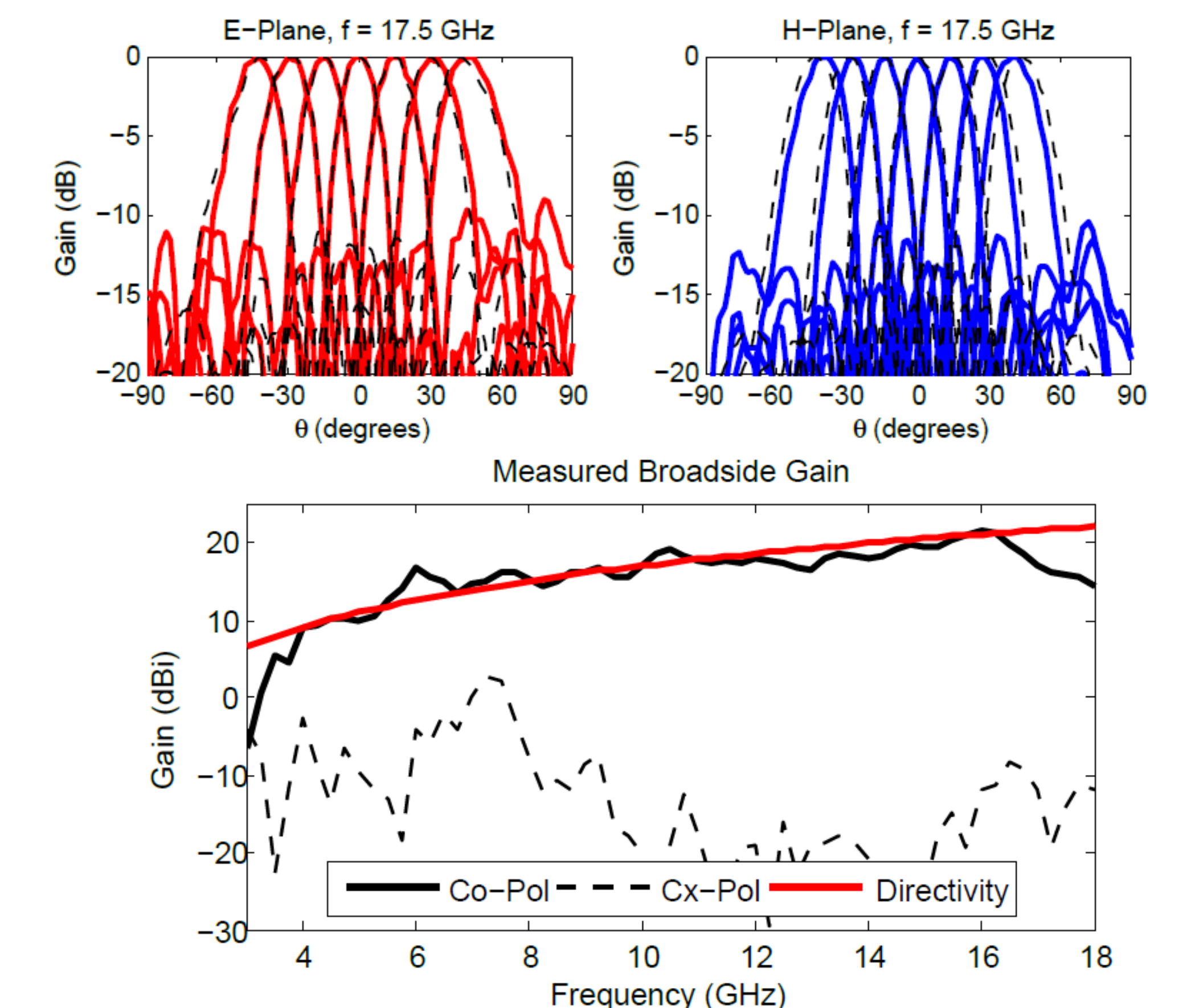


Phase Correction:
Displacement of even 1mm between measurements can cause significant phase discrepancies at 18 GHz. We use the measured phase response to derive the physical position of the array, and compensate measurements accordingly.



RESULTS

Measurements show close agreement with simulation. Low frequency beamforming is limited by the small size of the prototype.



CONCLUSIONS

Satellite applications can benefit from development of a low-profile UWB array, to support a multi-functional aperture.

We demonstrate here such an array, having:

- 3.5–18.5 GHz operation, scalable up to 49 GHz
- Scanning down to 70° in the E-plane, and 45° in H-plane
- Low-cost PCB fabrication
- Simulations verified in measurement

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